

BELLCOMM INC

SUBJECT Review of Instrument Unit
 Emergency Detection System at
 IBM/Huntsville on September 1
 Case 330

DATE: October 12, 1966

FROM: T. F. Loeffler

ABSTRACT

A review of the implementation of the Apollo Saturn Emergency Detection System (EDS) in the Instrument Unit (IU) was held by representatives of MSC, MSFC, NAA, IBM/Huntsville and MAS/Bellcomm at the IBM FSD facility in Huntsville, Alabama, on September 1, 1966. This memorandum serves as the minutes of the meeting.

Formal presentations covered descriptions of design, manufacturing, inspection and test sequences, philosophy of implementation, criteria for major EDS components, and problem areas, etc. Questions, discussions, and observations of the EDS Review Team were focused upon areas where single point failures could cause any trouble, as a result of the mechanical non-redundancies found in the SIB and SIVE stages, special attention was directed toward the implementation *or* the electrical/mechanical design.

Problem areas found were.

1. Mechanically non-redundant connectors, cables, and other components represent single failure points of (redundant) electrical EDS functions in a number of places in the IU. An MSFC action item has been generated previously, and a resulting request for Engineering Change Proposals (ECP's) for correction of this problem has been sent to the contractor.
2. Two single electrical paths each in the auto abort inhibit circuits. IBM proposed new parallel branches in each of the circuits to provide redundancy.

Discussion of problem areas, questioning during the review, and the inspection of the hardware revealed no other significant problems. Other problems that have been found to date have been alleviated or are presently in the process of getting corrected. Good cabling layout and wiring quality was observed during the inspection of the manufacturing, assembly, and test areas.

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(NASA-CR-153652) REVIEW OF INSTRUMENT UNIT
EMERGENCY DETECTION SYSTEM AT IBM/HUNTSVILLE
ON SEPTEMBER 1 (Bellcomm, Inc.) 18 p

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BELLCOMM, INC

SUBJECT: Review of Instrument Unit Emergency
Detection System at IBM/Huntsville
on September 1 - Case 330

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MEMORANDUM FOR FILE

A review of the implementation of the Apollo Saturn Emergency Detection System (EDS) in the Instrument Unit (IU) was held by representatives of MSC, MSFC, NAA, IBM/Huntsville and MAS/Bellcomm at the IBM FSD facility in Huntsville, Alabama, on September 1, 1966. This memorandum serves as the minutes of the meeting. The list of attendees is given in Appendix A. This meeting was the fourth one of the EDS implementation reviews that were initiated at the request of the EDS subpanel of the Apollo Saturn Electrical Panel. The three previous reviews covered the CSM,* SIB,** and SIVB,*** portions of the EDS respectively.

Because of the critical interdependence of EDS circuitry and components in various stages of the space vehicle, this set of reviews is intended to cover the EDS, and related items of interest in the Saturn PB vehicle stages and Block I CSM's, with the basic objectives of:

1. Insuring that the implementation of the integrated. EDS properly supports the design objectives of the system, as expressed by intercenter panel document.
2. Verifying that the checkout of the entire EDS is adequate to establish readiness for flight.

Mr. R. Ehrhardt, Manager of IU Engineering, IBM, opened the meeting with introductions, and the agenda for the meeting. Subsequently, a two-part presentation was given. Mr. J. Vollmer covered TU EDS design implementation, and Mr. A. Ermalinski gave a brief rundown of EDS checkout and systems testing.

Items discussed during and after this presentation were as follows:

"Review of CSM Emergency Detection System at NAA, on July 28, T. F. Loeffler, dated August 17, 1966

**Review of SIB Emergency Detection System at Chrysler-Michoud on August 20, 1966, T. F. Loeffler, dated August 28, 1966

***Review of S-IVB Emergency Detection System at Douglas Aircraft Corp., Huntington Beach, Calif., on August 16, T.F. Loeffler, dated September 8, 1966

1. Information flow and sequence of events from the time of receipt of ICD's through assembly, inspection and final test phases of manufacturing of IU components such as cabling, control signal processor, rate gyros, etc. For further detail see Figures 1-4 in Appendix B.
2. Principal electrical design requirements were stated for the following:

Primary Batteries:	80% of full capacity
Cabling and Wiring:	50% of full capacity, minimum wire gage - AWG 24
Cabling Voltage Drop:	2 volts maximum
Measuring Power Supply:	5V±0.1%
3. IU Electrical System: The functional block diagram of Figure 5, Appendix B, was shown and explained.
4. Voting relay and associated circuit design philosophy: The 9 items shown on Figure 6, Appendix B, were discussed.
5. IU EDS component design criteria were given as:

Rate Gyros.	Triply Redundant
Control Signal Processor:	Pair & Spare Redundancy
EDS Distributor:	a. Manual abort - Redundant
	b. Auto Abort - Triply Redundant
EDS Timer:	Backup Component (for IU Switch Selector)
6. IU 201 Problems and Their Solutions: In the Control Signal processor excessive vehicle vibration (during SA-201) caused noisy signal in the gyro circuits. This problem was solved by inserting a low pass filter into the circuit. A harmonic distortion problem in the rate gyro circuits was solved by changing of scale factors.
7. Single Point Failure Problem Areas; There is only a single cable (and connector) each leading from the TU Batteries to the Power Distributor, from there to the Auxiliary Power Distributor, and then to the EDS Distributor, as shown in Figures 9A & B. Proposed new cable branches in parallel with the present ones would provide the desired redundancy.

There is only a single connector for all outputs and power inputs etc., on the rate gyro package, which contains the 3 sets of 3 rate gyros. The cable leading from this unit to the IU control signal processor is also non-redundant at present.

In the IU Control Distributor, there is a single path each, in the two "excessive rate inhibit" and the "two-engine out inhibit" circuits, as shown in Figure 10A. The proposed redundancy shown in Figure 10B would provide the desired dual paths.

A question was raised regarding the type and extent of insulation of the 6D95 Auto Abort Bus bar; it was agreed that an insulating coating would be applied in all exposed places to prevent accidental contacts to these bus bars.

Mr. W. Shields indicated that MSFC has initiated an official request to the respective launch vehicle stage contractors to assess the extent and the impact upon AS-204, of modifications necessary to alleviate conditions of mechanical non-redundancy of vital EDS electrical connectors, cables, and other components.

8. EDS Checkout and Systems Testing. The sequence of EDS checkout was given as follows.
 - a. Power distribution and controls check; buses sequencing, etc.
 - b. EDS Systems Test 100% exercise of all functions
 - c. Rate Gyro Tests Output parameters verified in response to incremental pulsed torque
 - d. "SIM-PLUG"; electromagnetic interference
 - e. "SIM-FLIGHT"; complete simulated flight, with a "two-engine out" condition simulated at T+105 sec, and engines restarted at T+115 sec.

The EDS systems test constitutes the "acceptance tests," but in addition, all the tests are monitored by the respective customer inspectors. The tests are performed with the RCA-110 checkout computer in conjunction with the Auto Test Operation Launch Language (ATOLL) program, all discrete inputs and outputs are recorded, and the "Post Events Processor" compares these to the predicted values. If divergence from the predicted events occurs, it is flagged and the reason for it is investigated.

In conclusion of the presentation, Mr. Ermalinski indicated that the EDS distributors are not checked thoroughly enough prior to the test sequence, however, this condition has since been alleviated..

Subsequently, the Saturn V Control Room, and then the IU component assembly areas have been visited. In the "High-bay" area IU No.'s 205, 502, 503 and 206 were inspected in various stages of assembly and test, the previously discussed problem areas were pointed out, and these as well as all other EDS elements were examined by the EDS review team.

The cable fabrication shop areas were shown at the end of the tour. Careful workmanship was apparent in both areas.

In conclusion, Messrs. A. Dennett/MSFC, W. Shields/MSFC, H. Pringle/NAA, J. Vollmer/IBM, J. Cochran/MSFC and the author met for a critique and review of the findings of the EDS review. The highlights of the summary are given below.

SUMMARY

Mechanical non-redundancy of (redundant) EDS functions (in cables, connectors, etc.) exists in a number of places on the IU as described earlier. An MSFC action item has been generated to correct this problem. A recommendation will be made to ASEP for changes of at least the most vital connectors and cables for AS-204 (and subsequent). Requests for assessment of the extent and the impact upon AS-204 of modifications in the IU has been sent to IBM via the normal channels.

Discussion of problem areas during the meeting, and the inspection of the hardware revealed no significant problems other than the previously discussed ones. Other problems that have been found to date have been alleviated, or are presently in the process of getting corrected. With the exception of the previously mentioned mechanical/non-redundancy, the hardware inspection revealed generally good cabling layout and wiring quality.

The presentation was very good, the slides augmented the presentation well, and the identifying marks on the EDS prints in IU #502 in the High-Bay area were helpful in locating the respective EDS components. The IBM team was complimented for good performance of the IU EDS review presentation.

ORIGINAL SIGNED BY

2031-TFL-sam

T. F. Loeffler

Attachments

List of Attendees
Figures 1-10B

copy to
(See next page)

copy to

Messrs. L. E. Day - NASA/MAT
 J. L. Holcomb - NASA/MAO
 T. A. Keegan - NASA/MA-2
 M. L. Seccomb - NASA/MAP
 J. H. Turnock - NASA/MA-4
 G. C. White, Jr. - NASA/MAT
 W. J. Willoughby - NASA/MAR

A. Cohen - MSC/PD4
 A. Dennett - MSC/PD4
 E. B. Hamblett - MSC/PD2
 S. C. Jones - MSC/PD4

J. L. Cochran - MSFC/I-I/IB-E
 H. J. Fichtner - MSFC/R-ASTR-E
 W. G. Shields - MSFC/R-ASTR-E
 F. E. Vreuls - MSFC/I-I/IB-B
 L. C. Woods - MSFC/R-ASTR-E

D. C. Moja - KSC/LV-22

C. Bidgood
 D. R. Hagner
 W. C. Hittinger
 B. T. Howard
 P. R. Knaff
 J. Z. Menard
 I. D. Nehama
 T. L. Powers
 M. M. Purdy
 I. M. Ross
 T. H. Thompson
 G. B. Trousoff
 R. L. Wagner

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APPENDIX A

ATTENDEES AT IU EDS REVIEW MEETING

September 1, 1966

NAME	ORGANIZATION	
T. F. Loeffler	MSF-MAS/Bellcomm	269-8538
R. A. Warren, Jr.	IBM-Elec. System	837-4000
L. E. Stumbough	IBM EDS System	
H. D. Thompson	IBM EDS System	
A. Ermalinski	IBM System Test	X2070
A. H. Toman	IBM Cont. Equip. Engng.	X2151
J. L. Cochran	MSFC I-I/IB-E	876-9113
W. G. Shields	MSFC/A-ASTR-EA	876-5321
A. Dennett	MSC PD5	HU3-5121
H. Pringle	NAA EDS Systems Engineering	923-8111
R. Ehrhardt, Jr.	IBM Mgr. of IU Engineering	837-4000 X3441/2
J. L. Cahalan	IBM Mgr. IB Electrical Systems Des.	X2018 X2342
J. B. Vollmer	IBM Mgr. V Electrical Systems Des.	X2028
A. B. Adkins	IBM Reliability Analysis	X2835
M. P. Waligora	IBM Quality Test Manager	X2539

APPENDIX B

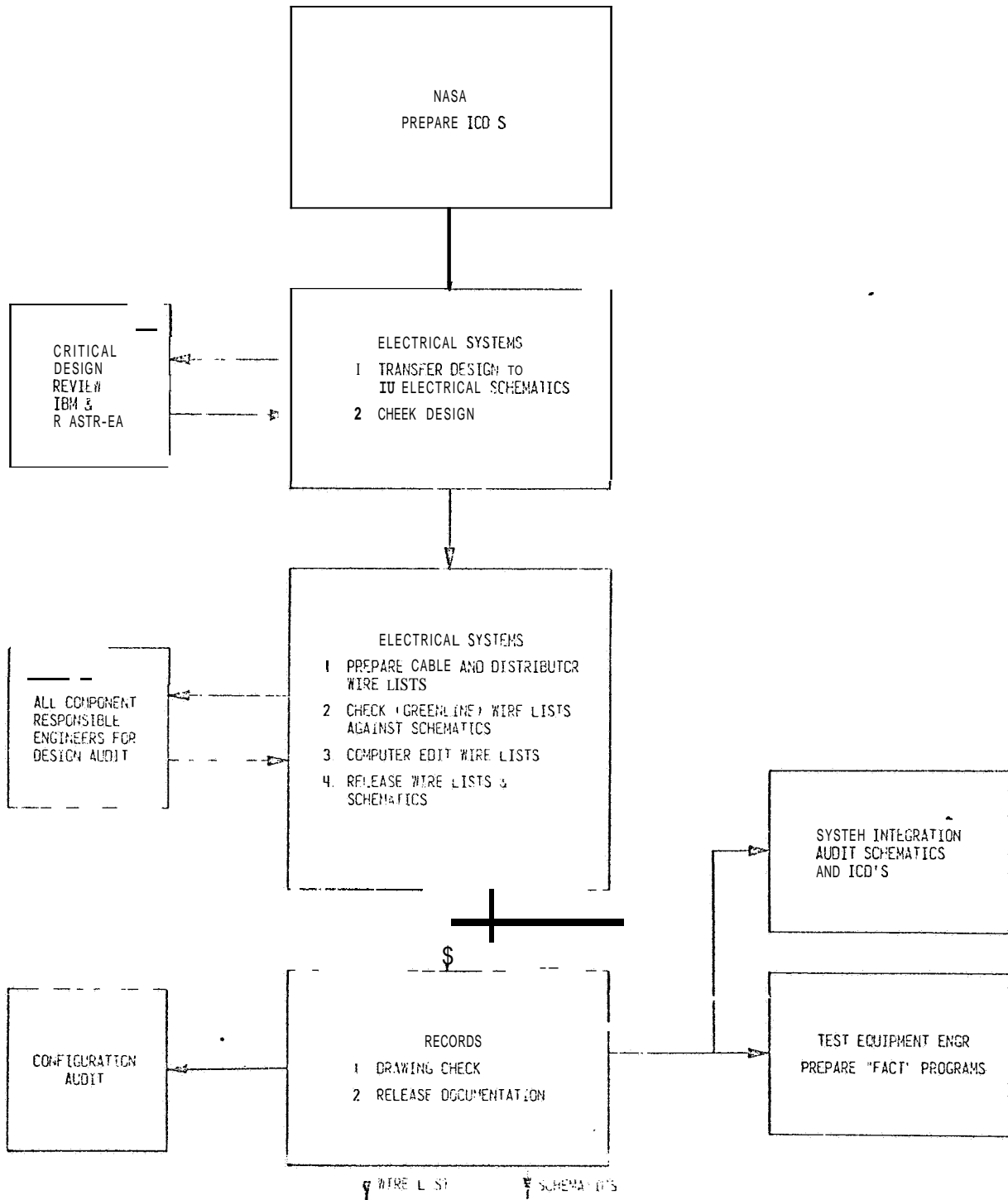


FIGURE 1

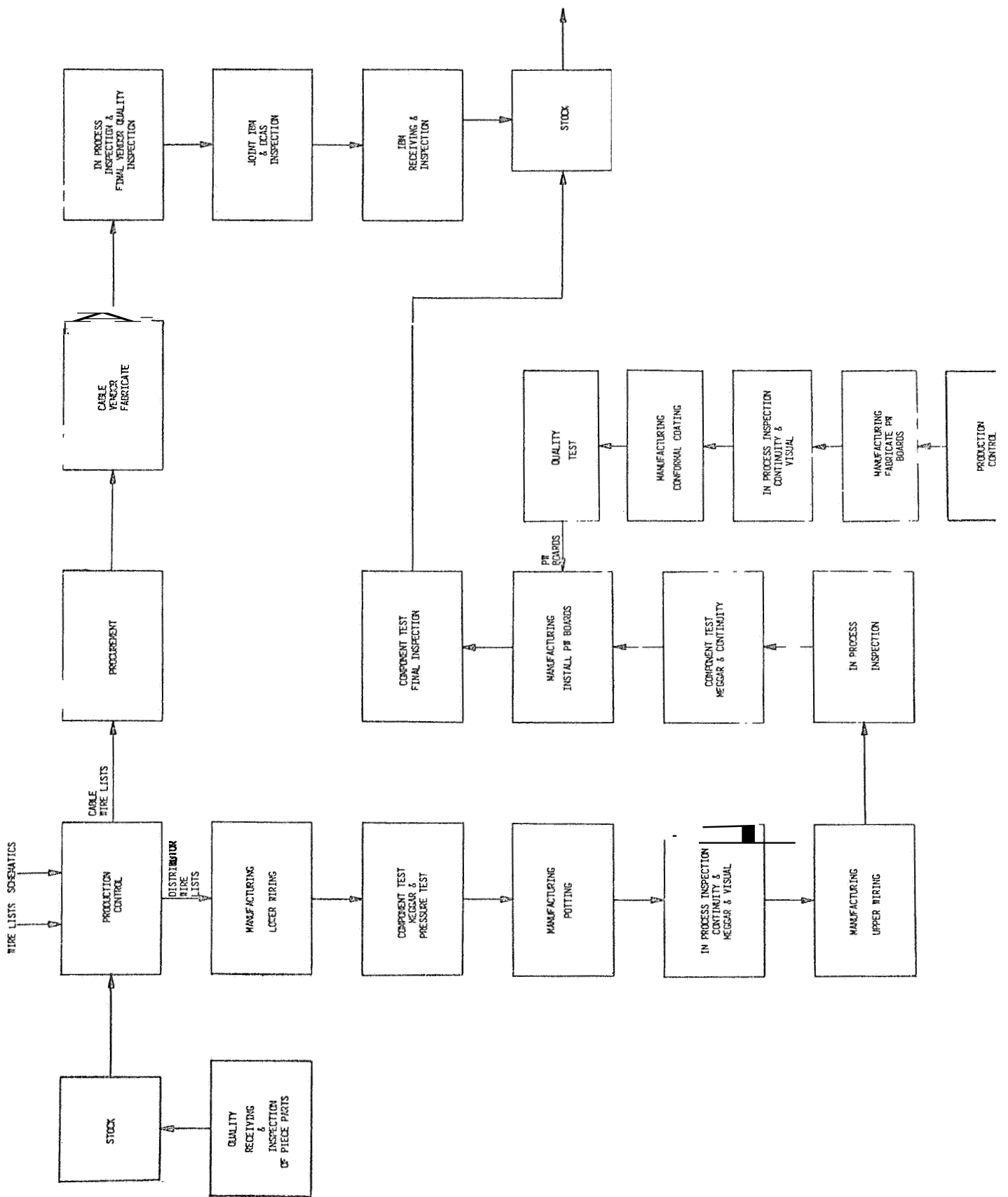


FIGURE 2

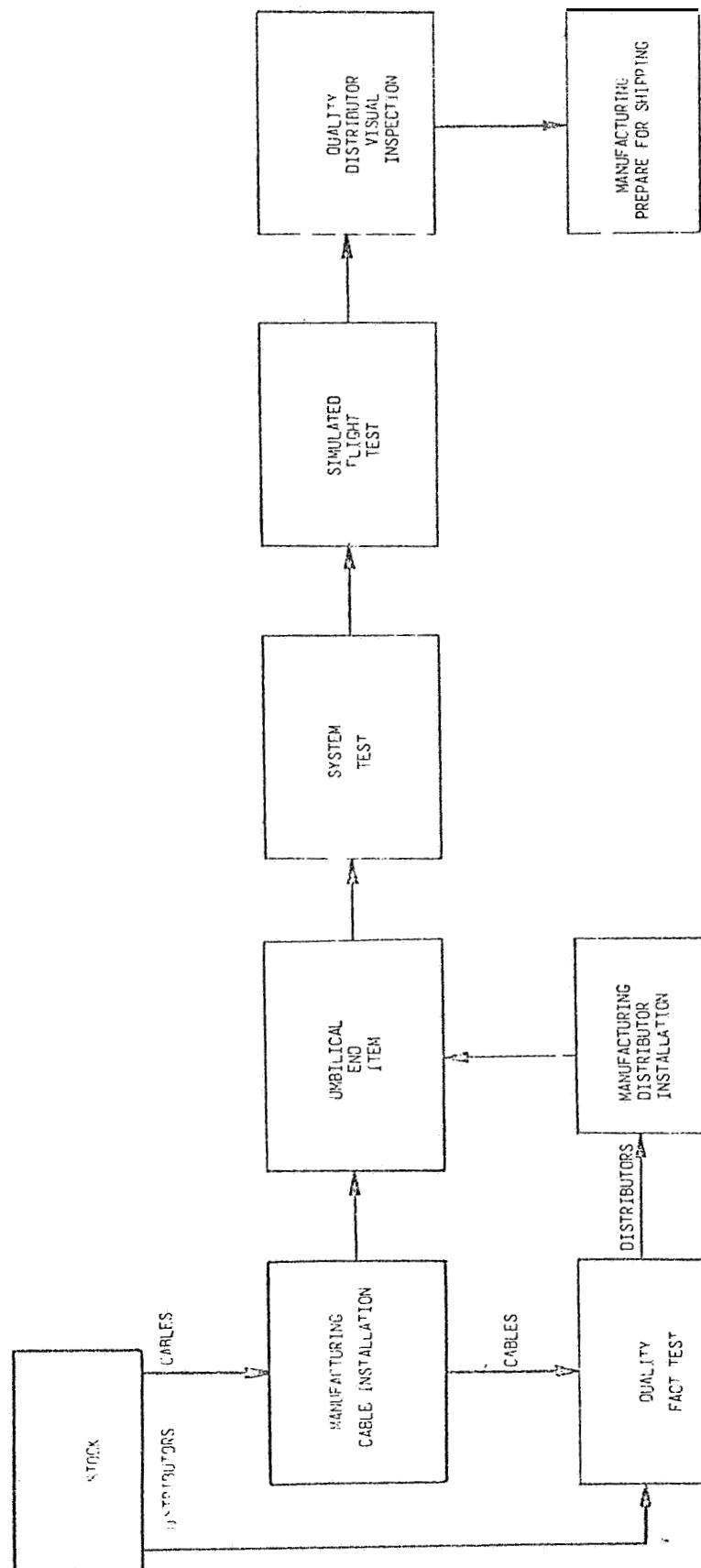
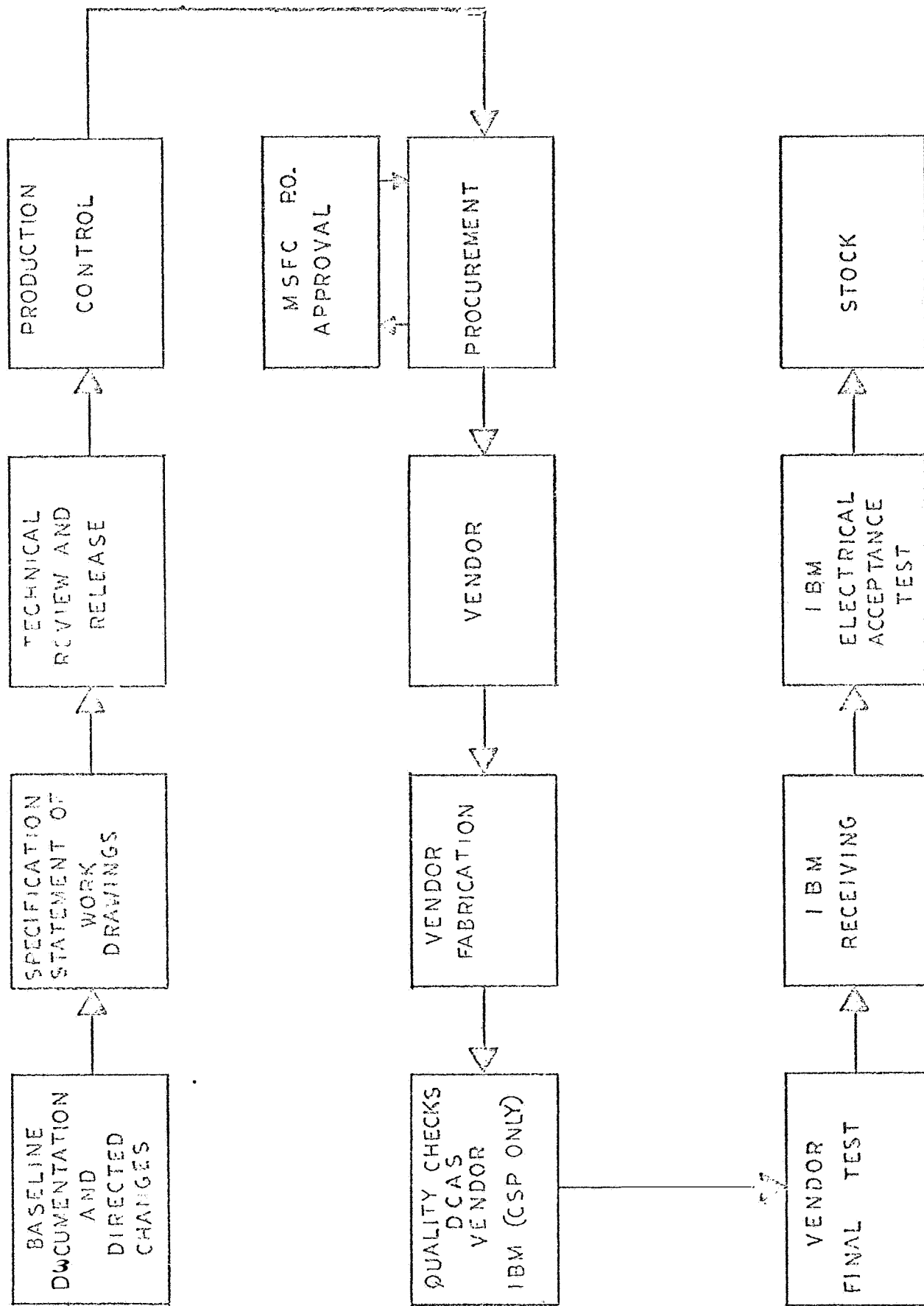


FIGURE 3



CONTROL SIGNAL PROCESSOR 3 RATE GYROS

FIGURE 4

GSE
POWER

BATTERIES
(4)

GSE OR
SWITCH SELECTOR
SWITCHING

UMBILICAL

POWER DISTRIBUTOR

56 VOLT
POWER
SUPPLY

AUXILIARY
POWER
DISTRIBUTOR

AUXILIARY
POWER
DISTRIBUTOR

5 VOLT
MEASURING
SUPPLY

MEASURING
DISTRIBUTOR

MEASURING
DISTRIBUTOR

EDS
DISTRIBUTOR

CONTROL
DISTRIBUTOR

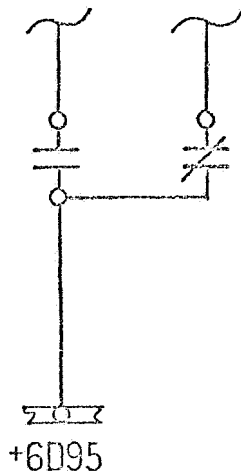
MEASURING SENSORS

TO SPACE CRAFT,
S-113 STAGE AND
S-118 STAGE

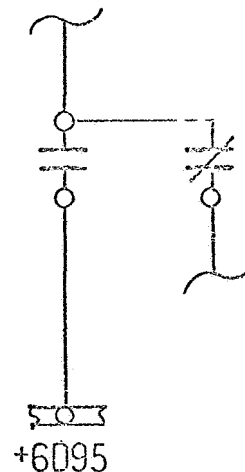
IU COMPONENTS

- 1 EACH LEG OF A VOTING CIRCUIT IS ASSIGNED TO A DIFFERENT PRINTED WIRING BOARD IF BOARD MOUNTED
- 2 EACH LEG OF A VOTING CIRCUIT IS ASSIGNED TO A DIFFERENT CABLE
- 3 THE ABOVE (1 & 2) ARE TRUE FOR REDUNDANT CIRCUITS
- 4 HEAT REACTIVE TUBING COVERS ALL WIRE AND PRINTED WIRING BOARD TERMINALS AND RELAY TERMINALS WHERE AN ACCIDENTAL SHORT CIRCUIT COULD CAUSE AN ABORT
- 5 THE ARMATURE POLE OF A SET OF RELAY CONTACTS SHALL NOT BE TIED TO THE +6D95 BUS AN ACCIDENTAL SHORT ON A NORMALLY CLOSED CONTACT WOULD CAUSE AN AUTO ABORT

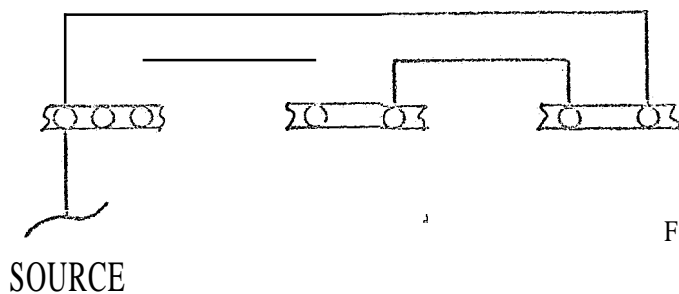
INCORRECT



CORRECT



- 6 ALL VOLTAGE BUSSES ARE LOOP WIRED
7. CRITICAL ABORT FUNCTIONS ARE LOOP WIRED
8. RELAY RETURNS ARE LOOP WIRED
- 9 COMMON BUSSES ARE LOOP WIRED



EXAMPLE

FIGURE 6

EDS - IU COMPONENTS DESIGN CRITERIA

Rate Gyros	- Triple redundant
Control Signal Processor	- Pair & Spare Redundancy
EDS Distributor	- Auto Abort Triple Redundant Manual Abort - Redundant
EDS Timer	- Backup Component

FIGURE 7

IU 201 PROBLEM AREAS

Control Signal Processor

Problem - High vehicle vibration

Solution - Add low pass filter

Rate Gyros

Problem - Warmonic distortion

Solution - Change scale factor

FIGURE 8

BLOCK DIAGRAM REDUNDANT POWER TO EDS UCN 4853

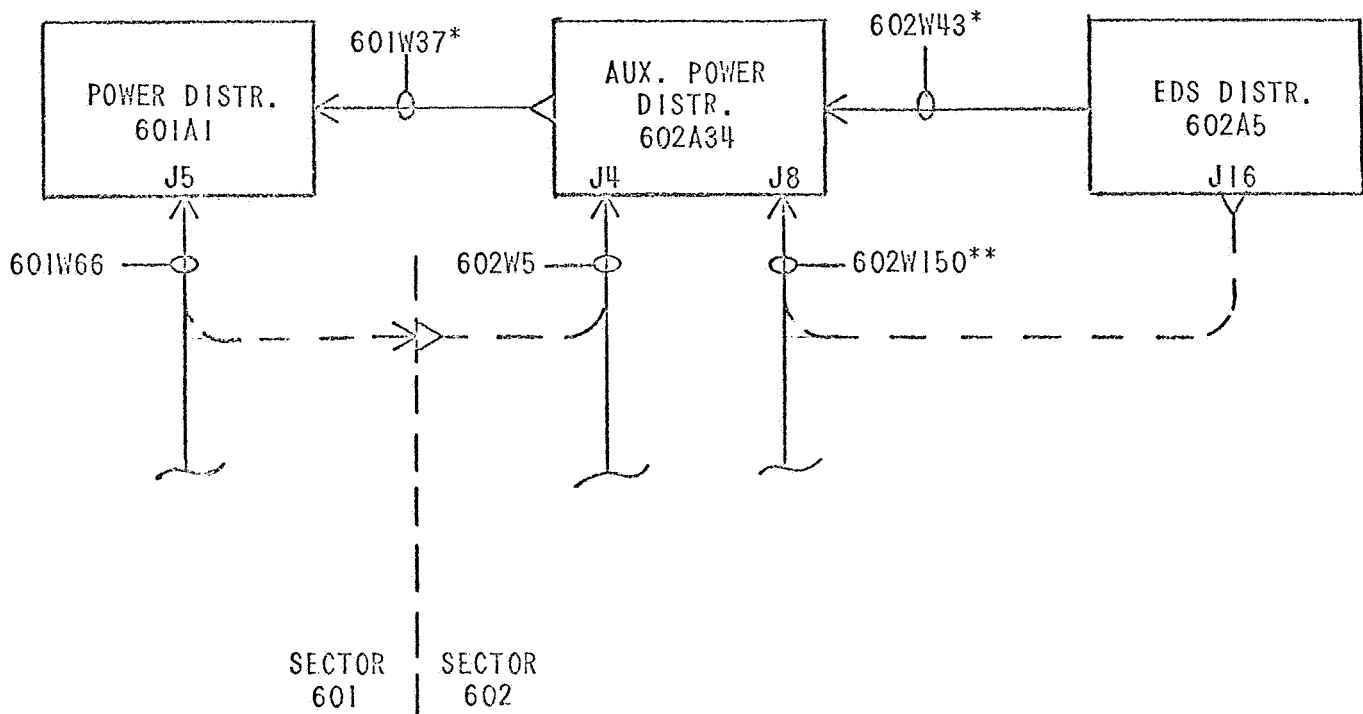


FIGURE 9A

CIRCUIT DIAGRAM REDUNDANT POWER TO EDS UCN-4853

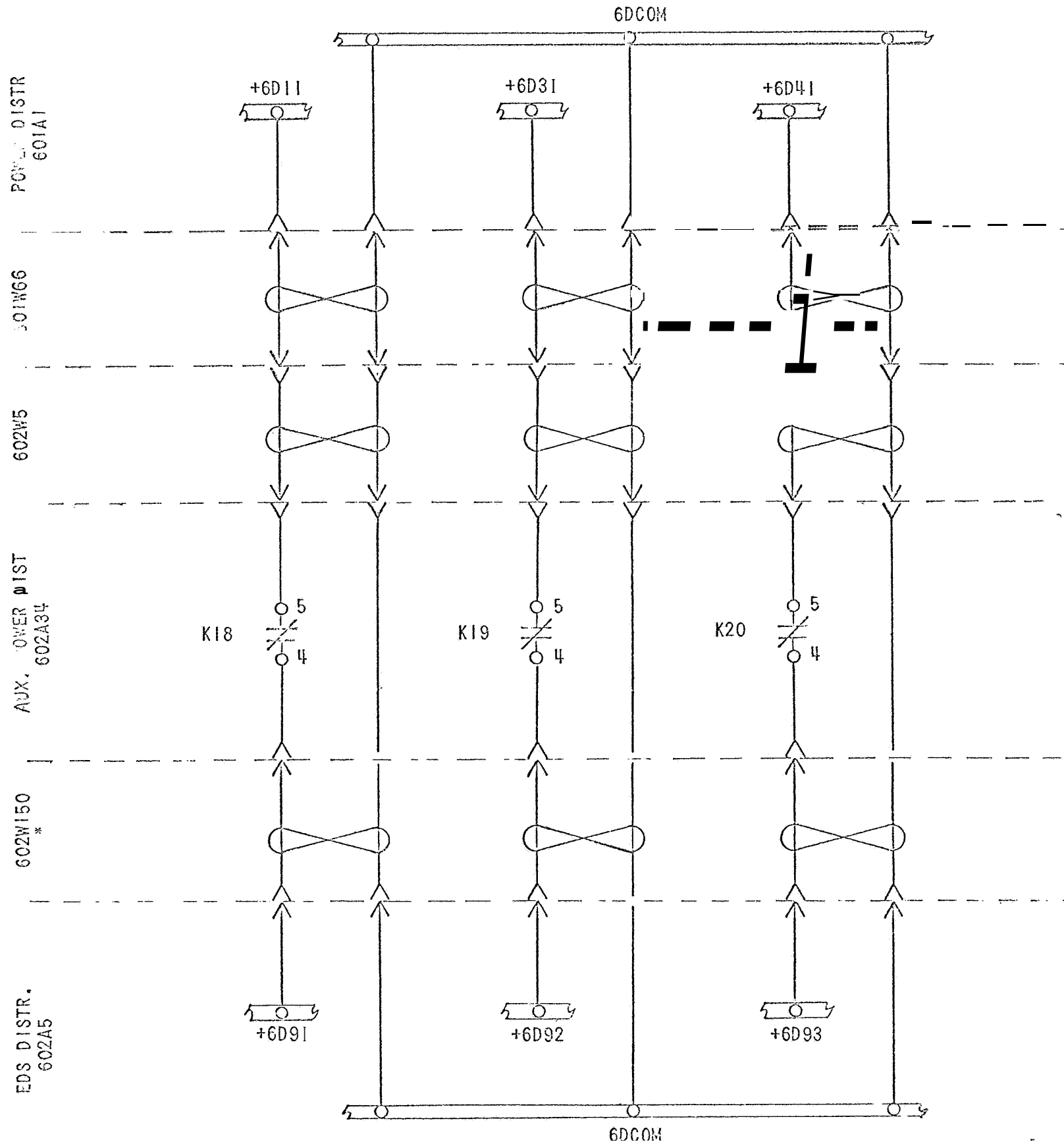


FIGURE 9B

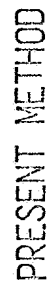
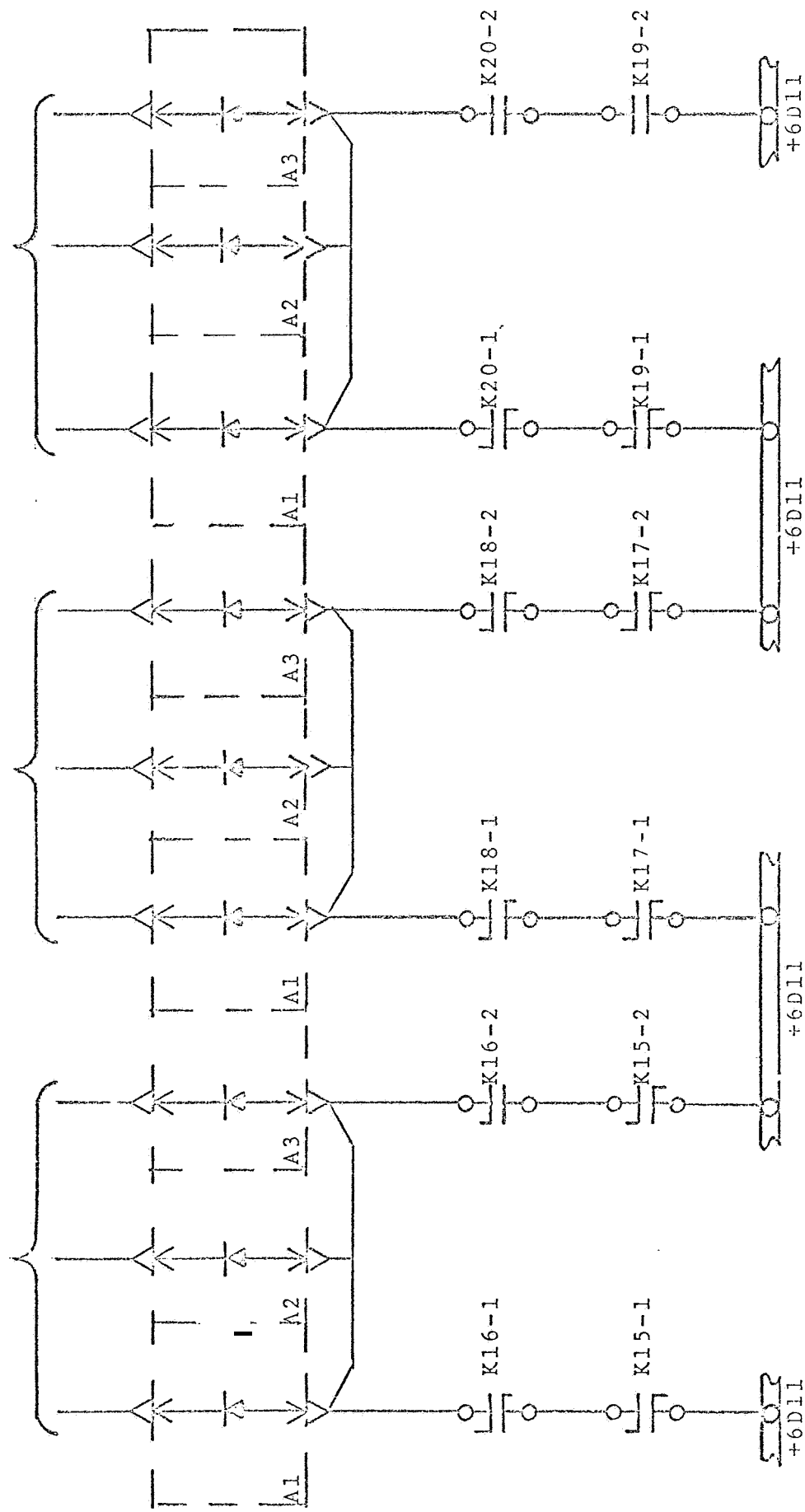


FIGURE 10A

EXCESSIVE ROLL, PITCH, YAW
AUTO ABORT INHIBIT

EXCESSIVE ROLL
AUTO ABORT INHIBIT

2 ENGINE OUT
AUTO ABORT INHIBIT



PROPOSED METHOD

FIGURE 10p